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Kinzel, Moritz; Sølling, Theis Ivan; Sobott, Robert

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R. Sobott (Friedrich-Alexander-Universität Erlangen-Nürnberg)
M. Kinzel, T. Sølling (University of Copenhagen)

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INTRODUCTION

The once prosperous and flourishing merchant and pearling town of Al Zubarah, situated at the upper NW coast of the Qatar peninsula and founded about 1760 AD by the Banu Utaba tribe from Kuwait, was gradually abandoned in the 2nd half of the 19th century and finally given up at the beginning of the 20th century. Apart from the removal of commodities which could be used for building and living at other places it was not destroyed but handed over to nature. The desert sand covered the partly ruined buildings and thus conserved the entire layout and fabric of the town. Since 2009 the University of Copenhagen in partnership with Qatar Museums is excavating and conserving some areas of the over 60 hectares large site. The abundance of archaeological finds comprising among other items porcelain and celadon from China, pottery from India and silver coins from the Austrian-Hungarian Empire attests to the wealth gained from pearl fishing and the world-wide trade links of merchants from Al Zubarah. The excavated implements and articles of daily life convey pictures of the bustling life in workshops and houses. Quite a number of tools, for instance rotary querns, pounders, whetstones and diving weights, were made from natural stones or minerals (Figure 1).

The observation that the mostly magmatic and metamorphic rocks do not come from the sedimentary beds and gravel fields of Qatar raises two questions: 1. from which location or area on the Arabian Peninsula or in Iran do the minerals and rocks originate, and 2. were the tools imported ready-made or produced in Al Zubarah from imported raw materials. The diverse nature of the rocks and minerals suggests a complex answer. While it seems undisputed that all goods reached Al Zubarah by sea transport the answers to the two questions cannot be so definite. Much speaks in favour for the notion that elaborate tools made from uncommon raw materials, for example hematite or barite, were imported as ready-made goods, while more basic and simple tools worked from limestone or dolomite were produced locally. This does most probably apply to the frequently found dolomite balls of different sizes which were used in *madbasas* (date presses) as stoppers for the jars in which *dhibs* (date syrup) was collected. However, can shape a hard dolomite rock which can be picked up almost everywhere in the surroundings of Al Zubarah into a perfect ball, can also work other stone material. It is expected that the petrographical analysis of the rocks will help to reveal their provenance.

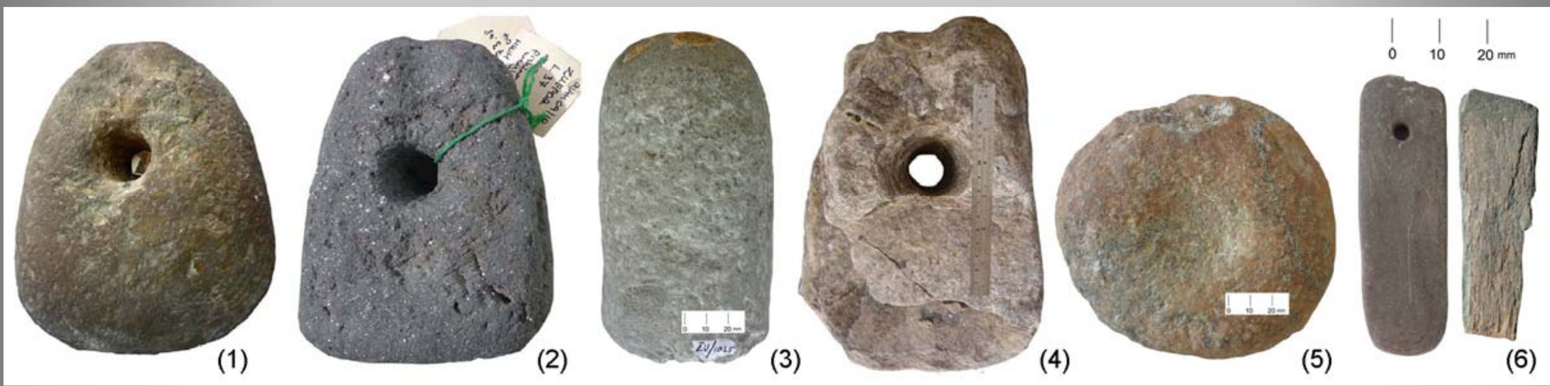

Figure 1: Natural stone implements: 1 quartzite diving weight, 2 hematite diving weight, 3 altered gabbro pestle, 4 barite diving weight, 5 altered peridotite hammer, 6 quartz sericite schist whetstone

Chemical and petrographical analyses

Quantative chemical analyses were carried out on tablets prepared from sample material ground down to grain sizes below 10 µm with an EDX system attached to a JEOL scanning electron microscope. For qualitative phase analysis X-ray diffractometry and polarized light microscopy were used. The quantitative chemical composition data was used to compute quantitative mineral phase compositions on the basis of the qualitatively identified mineral phases. The optical light microscopy of some samples was backed by analyses with a QEMSCAN system stationed at the Maersk Oil Research and Technology Center in Doha (Figure 2).

Table 1: Chemical and mineralogical composition of 5 (out of 14) rock samples

Sample	Na_2O	K_2O	MgO	CaO	MnO	Fe_2O_3	Al_2O_3	SiO_2	TiO_2	Cl	Sum
01 Granite Qz, Kf, Pl, Bi,Hb	1,64	7,65	1,20	0,52	-	1,74	11,58	75,36	0,00	0,27+)	100,01
08 Harzburgite Ol, En, Li	-	-	42,54	1,80	-	0,96	11,86	42,30	-	0,55+)	100,01
10 Gabbro Pl, Di, Ch	2,98	2,67	5,38	9,47	-	15,36	9,11	54,10	0,93	-	100,00
11 Basalt Pl, Pi	2,92	4,27	8,42	5,32	0,27	16,37	11,68	49,35	1,39	-	99,99
13 Porphyry Qz, Kf, Mu	1,46	9,59	1,99	5,70	-	12,95	3,93	63,37	1,01	-	100,00

+) Cl contents results from contamination of sample with NaCl in the sabkha and was obviously not completely removed by the washing process (Qz: Quarz, Kf: K feldspar, Pl: Plagioclase, Bi: Biotite, Mu: Muscovite, Ch: Chlorite, Hb: Hornblende, Di:Diopside, Pi: Pigeonite, En: Enstatite, Li: Lizardite)

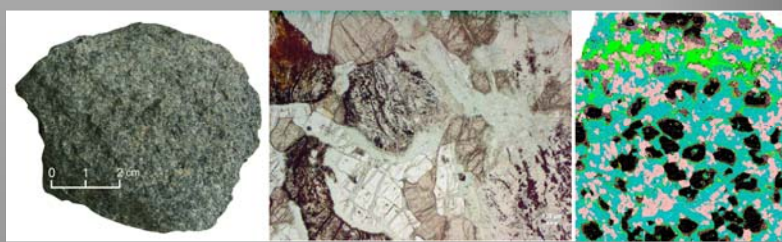

Figure 2: Handspecimen, thin section & QEMSCAN image of sample 10 (Gabbro)

The quantitative mineral composition of the rocks was calculated from the combination of the qualitative phase and quantitative chemical data . For example, the calculation produced the following result for sample 01 Granite (contents in mass%) : K-feldspar 41 , albite 15,5, quartz 35, biotite 6,9, hornblende 1,6.

Discussion

As far as the mafic to ultramafic rocks are concerned, the ophiolites in Oman and UAE are potential sources for peridotite, gabbro and basalt. Some of the outcrops are situated close to the coast of the Gulf of Oman, and it is conceivable that rock material was taken on board as ballast. Some of the gabbroic rocks have undergone intensive low-grade metamorphic alteration (saussuritization). Probably the altered gabbro was easier to work on because this material was also frequently used for tool-making The most likely hematite supplier seems to be Iran which is still one of the biggest iron ore producers in the world. Small apatite crystals in some of the hematite samples can be distinguishing feature. Barite may also come from Iran. Large deposits are located in the Haji Abad regions in Kashan, Isfahan Province, and Yazd, Province Yazd. Besides the chemical and petrographical analyses the work draws on three important resources, namely visits to museums in Bahrain, Doha, Dubai, Abu Dhabi and Muscat, the literature about trading in the Gulf area and the published regional geology of the Arabian Peninsula.

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Robert Sobott GeoZentrum Nordbayern, Friedrich-Alexander-Universität, Erlangen-Nürnberg
Schlossgarten 5, D-91054 Erlangen (lfbd-sobott@t-online.de)

Moritz Kinzel, Carsten Niebuhr Centre for Multicultural Heritage, University of Copenhagen
Karen Blixens Vej 4, DK-2300 Copenhagen S (zdr147@hum.ku.dk)

Theis Ivan Sølling, Institute of Chemistry, University of Copenhagen
C, Bygning: C516 DK-2100 København ø (theis@chem.ku.dk)